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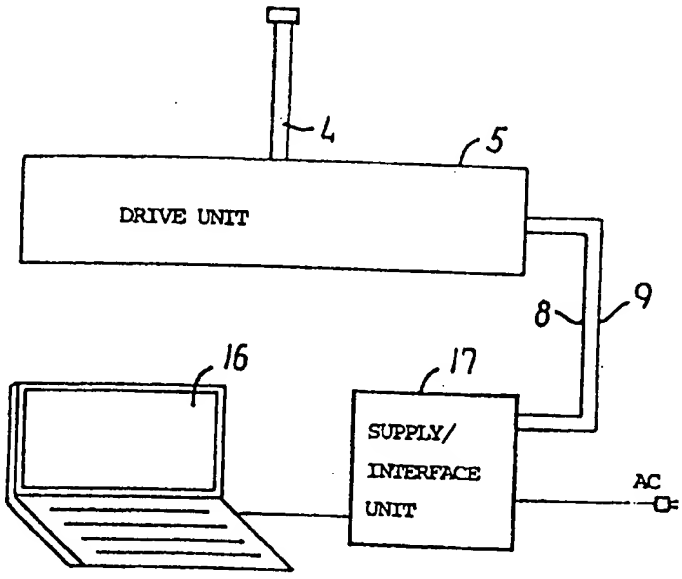
(54) Title: A MICROPROCESSOR–CONTROLLED DRIVE UNIT FOR ELECTRICALLY OPERATED DEVICES

(57) Abstract

A drive unit for electrically operated doors, windows, screening devices and the like, comprises a drive unit casing (5) containing a motion transfer member (4) in engagement with a reversible drive motor (1) with an associated motor control circuit. The drive unit is designed as a program–controlled unit with a microprocessor (6) with an associated reprogrammable memory (7) which contains operating parameters for the drive motor (1) and can be programmed and reprogrammed from the outside via the current supply conductors (8, 9) to the drive unit by means of an external programming device (16) via an interface unit (17) which by connection to the current supply conductors (8, 9) brings these into a programming condition deviating from a normal operating condition and in which data can be exchanged between the microprocessor (6) and the external programming unit (16).



A microprocessor-controlled drive unit for electrically operated devices

The present invention relates to a drive unit for electrically operated devices such as doors, windows, screening devices and the like, comprising a drive unit casing designed for stationary mounting and containing a motion transfer member designed for connection with the operated device and in engagement with a reversible drive motor with an associated motor control circuit which drive unit is designed as a program-controlled unit, the motor control circuit comprising a microprocessor with associated memory containing operating parameters for the drive motor.

Such microprocessor controlled drive units are known in different designs, inter alia from US patents nos 5,285,137 and 5,371,447 and the EP patent applications nos 0 493 322 and 0 618 338 and have been developed for the purpose of ensuring a reliable electrical operation in particular of windows which are difficult to access for manual operation.

In a curtain drive unit known from US patent no. 5,371,447, an EPROM unit is used in connection with the microprocessor for storing an operation program which comprises predetermined data for curtain positions and movement times.

In a window drive unit known from US patent no. 5,282,137, a control program is stored in an internal ROM in the microprocessor which via an interface unit can be controlled partly by remote control and partly by signals from different external sensors such as a rain sensor.

Likewise, in a curtain drive unit known from EP patent application no. 0 493 322, an EPROM is connected to a microprocessor for storing information on the movement direction activated by a prior operation.

In a control circuit known from EP patent application no. 0 618 338 and which is common for a number of

drive units which may comprise lock or bolt disengagement drive units as well as opening/closing drive units, an internal memory in a microprocessor is used for storing identification information about the types of the connected drive units together with data obtained by an initiating procedure for determination of the duration of a complete opening or closing movement.

It is therefore the object of the invention to provide a drive unit of the stated kind which is in particular distinguished in that it can easily be adapted for use in different applications, e.g. different window types or adjusted according to occuring load variations, e.g. wind loads, which can in particular influence the function of drive units for large window frames or production tolerances in the mechanical parts of the drive unit just as it can be readjusted even after mounting.

These and other advantages are according to the invention obtained by a drive unit of the stated kind which is characterized in that the memory is a reprogrammable memory which can be programmed and reprogrammed from the outside via the current supply conductors to the drive unit by means of an external programming device via an interface unit which by connection to the current supply conductors brings these into a programming condition deviating from a normal operating condition and in which data can be exchanged between the microprocessor and the external programming unit.

Advantageous embodiments for such a drive unit are stated in the subclaims.

In the following, the invention is explained more in detail with reference to the schematical drawing where

Fig. 1 is a block diagram showing the main components of a window drive unit according to the invention,

Fig. 2 shows the connection of the drive unit to an external programming device,

Fig. 3 shows the design of a circuit in the drive unit for the use in the exchange of data between the drive unit and the external programming device, and

Fig. 4 shows the design of a circuit for limitation of the current consumption of a further development of the drive unit.

The drive unit according to the invention is in the embodiment shown on the drawing designed as an self-contained, autonomous unit to be used e.g. in connection with a chain drive unit of the kind which is well-known for opening and closing different window types, in particular roof windows.

The drive unit comprises as main components a reversible electrical drive motor 1 which via a built-in transmission 2 is connected to a drive member for the adjustement member of the drive unit, e.g. a chain wheel 3 which is in engagement with a chain 4 which at one end is connected to a window frame whereas the motor 1, the transmission 2, and the chain wheel 3 together with the chain part 4 in engagement therewith and the electronic components in the drive unit are built into a casing 5 which is connected with the frame construction of the window.

For the control of all operating functions, the drive unit contains a microprocessor 6 with control programs stored in an internal ROM. To the microprocessor 6 is connected a reprogrammable EEPROM 7 where the operating parameters of the function of the drive unit in the actual use is stored. The current supply to the drive unit is effected via two current supply conductors 8 and 9 which can be connected to an operation keyboard 10 and in the drive unit are connected to a voltage regulator 11 providing a supply voltage V_{cc} to the microprocessor 6 and other electronic components in the drive unit and furthermore via a direction interface circuit 12 and a data read-

out circuit 13 is connected to the microprocessor 6.

The current supply conductors 8 and 9 are furthermore connected to a motor driver circuit 14 controlled by the microprocessor 6 and controlling connection and disconnection together with the rotating direction of the motor 1.

The microprocessor 6 can moreover be connected with an IR receiver 15 for the use in remote control of the drive unit from an IR remote control unit of a kind known per se.

According to the invention, the drive unit is designed for exchanging data with an external programming unit which as shown in Fig. 2 can be a portable PC 16 which via an interface unit 17 is connected to the current supply conductors 8 and 9 of the drive unit which in the operating condition is supplied with a DC voltage, e.g. a full-wave rectified supply voltage, the polarity of which determines the rotating direction of the reversible motor 1 of the drive unit.

In the programming arrangement shown in Fig. 2, the interface unit 17 is adapted for switching the polarity of the current supply conductors 8 and 9 at a frequency which is considerably higher than the mains frequency, e.g. 10 kHz, whereby the drive unit as explained in the following is brought into a programming or data exchanging condition deviating from the normal operating condition.

In the drive unit, the direction interface circuit 12 connected to the current supply conductors 8 and 9 contains as shown in Fig. 3 two RC couplings 18 and 19 each in connection with one of the current supply conductors 8 and 9. The direction interface circuit 12 emits to two inputs 20 and 21 on the microprocessor 6 direction control signals which in the normal operating condition are unambiguously determined by the polarity of the current supply conductors 8 and 9 and determine the rotating direction of the motor 1.

By way of example, if the current supply conductor 8 is positive compared to the current supply conductor 9, the capacitor in the RC coupling 18 is charged through the associated resistance, whereas the capacitor in the RC coupling 19 is discharged through the associated resistance whereby a direction control signal with the logical value "1" is emitted to the input 20, whereas a direction control signal with logical value "0" is emitted to the input 21. If, on the other hand, the current supply conductor 9 is positive compared to the current supply conductor 8, the direction control signals on the inputs 20 and 21 assume logical values "0" and "1", respectively.

By the switching of the polarity of the current supply conductors 8 and 9 at a relatively high frequency which is effected in the programming and data exchange condition, the capacitors in both RC couplings 18 and 19 are discharged such that the signals emitted to the inputs 20 and 21 of the microprocessor both assume a low level corresponding to logical "0" whereby the microprocessor is brought into the programming or data exchange condition.

Subsequent to the completion of the programming or data exhange and after disconnecting the programming and interface units 16 and 17 again, the microprocessor can only be brought back to normal operating condition by a separate reset operation, e.g. by giving an end command on the portable PC 16.

In the programming or data exchange condition, there can by entering suitable commands on the portable PC 16 either be transferred data representing predetermined parameter values from this to the microprocessor 6 and the EEPROM 7 connected thereto or there can be read out data stored in the EEPROM 7 or the microprocessor 6 to the portable PC 16.

The data transfer from the portable PC 16 to the microprocessor 6 can e.g. be effected in that the commands entered into the portable PC 16 in the

interface unit 17 are converted into bit patterns transferred to the drive unit by switching the polarity of the current supply conductors 8 and 9 at a suitably low frequency corresponding to a bit rate appropriate for reception and decoding of the information.

By way of example, data can be transferred to an interface unit 17 by a standard NRZ bit coding from the serial port on the portable PC 16. A transmission rate of 300 baud corresponding to a maximum pulse rate of 150 Hz is thus obtained. The transferred bit patterns can thus be decoded by the RC couplings 18 and 19 and from there be delivered to the inputs 20 and 21 of the microprocessor 6 instead of the direction control signals supplied in the normal operating condition.

In the microprocessor 6, a terminal 22 is connected to the EEPROM 7.

The transmission protocol for transfer of parameter information from the portable PC 16 to the microprocessor 6 can be organized in frames or pages with each 8 bytes consisting of a serially transferred bit string of 8 bits. At the beginning of the transmission, a byte is first transferred in the first frame with an instruction or command about started transmission followed by a byte identifying the parameter which is subsequently read and serves for addressing when writing in the EEPROM 7 and one or more control bytes. After a pause corresponding to the remaining duration of the first frame or page, the actual parameter information is transferred in the 8 bytes in the following frame upon which control frame ending information is transferred in the next frame. The transferred parameter data are buffered in a RAM in the microprocessor before being stored in EEPROM 7 which e.g. can have a capacity of 16 frames or pages of 8 bytes or a total of 128 bytes.

Programming and reprogramming of the relevant operating parameters can thus be effected in connection

with the production of drive units acording to the invention and at later times, e.g. in connection with the end mounting. In connection with the production, the programming can typically comprise serial numbers and calibration constants together with certain function parameters whereas in the end mounting it will typically be programming of operating parameters which can vary in dependence of the type of window, for which the drive unit is to be used and the working loads to which the drive unit can be expected to be subjected, and which typically can comprise maximum pull, speed or power or maximum opening degree for the window.

As mentioned in the above, a data read-out from the drive unit to the portable PC 16 can also be effected in the programming or data exchange condition, e.g. with the object of verifying the programmed operating parameters or reading out data which are logged in the drive unit.

The data read-out is effected from the microprocessor 6 by connecting and disconnecting the load resistance 23 shown in Fig. 3 by means of a transistor switch 24 and in accordance with the bit pattern required to be read out. The thus caused changes in the current drawn by the drive unit from the current supply conductors 8 and 9 can in the interface unit 17 be registered and converted to a digital signal which after a suitable level conversion can be delivered to the serial port on the portable PC 16.

The data read-out is effected by transfer of an instruction or command from the portable PC.

During normal operation, the microprocessor 6 controls the rotating direction for the motor 1 which is a DC motor, by activation of one of the two pairs of the field effect transistors 25, 26 or 27, 28 in the driver circuit 14, whereas the current and voltage to the motor are controlled by pulse width modulation in a PWM modulator 29 connected between the microprocessor 6 and the field effect transistors 25, 26 or

27, 28. The speed of the DC motor 1 determined by the motor voltage is monitored by the microprocessor by measurements of the motor voltage by means of a resistor network with resistances 30, 31, and 32 whereas the torque of the motor is monitored by voltage measurement via a current sensor resistance 33. In order to maintain the motor at a usually constant speed independently of the torque, the voltage measured by means of the resistor network 29-31 is compensated for the voltage drop over the internal resistance of the motor calculated by the measured motor current. The current drawn from the current supply conductors 8 and 9 can thus be calculated by multiplication of the measured motor current by the duty cycle of the pulse width modulated signal.

The program control in the microprocessor uses an adjustment algorithm which primarily tries to maintain a constant motor speed even though the motor is subjected to varying loads but such that a stored maximum current consumption is not exceeded.

As long as the motor current or the current consumption have not reached the programmed maximum values, the following applies for the voltage V_m over the motor terminals

$$V_m \doteq V_e + k * R_m * I_m,$$

where V_e is the EMF of the motor, I_m is the motor current, R_m is the internal resistance of the motor and k a constant which, for the stability, is smaller than 1.

When the current consumption reaches the programmed maximum, the motor voltage is reduced by control of the pulse width modulated signal, such that the motor current decreases to the programmed maximum whereby the motor speed is reduced.

PATENT CLAIMS

1. A drive unit for electrically operated devices such as doors, windows, screening devices and the like, comprising a drive unit casing (5) designed for stationary mounting and containing a motion transfer member (4) designed for connection with the operated device and in engagement with a reversible drive motor (1) with an associated motor control circuit which drive unit is designed as a program-controlled unit, the motor control circuit comprising a microprocessor (6) with associated memory (7) containing operating parameters for the drive motor (1), characterized in that the memory (7) is a reprogrammable memory which can be programmed and reprogrammed from the outside via the current supply conductors (8, 9) to the drive unit by means of an external programming device (16) via an interface unit (17) which by connection to the current supply conductors (8, 9) brings these into a programming condition deviating from a normal operating condition and in which data can be exchanged between the microprocessor (6) and the external programming unit (16).

2. A drive unit according to claim 1 where the rotating direction of the drive motor (1) in the normal operating condition is defined by the polarity by a DC voltage on the current supply conductors (8, 9), characterized in that the programming condition comprises switching the polarity of the current supply conductors (8, 9) at a frequency which is considerably higher than the mains frequency.

3. A drive unit according to claim 1 or 2, characterized in that the microprocessor (6) is adapted for logging of data during operation of the drive unit and, in said programming condition, for reading out such data and/or stored operating parameters from the reprogrammable memory (7) by microprocessor controlled connection and disconnection of a load resistor (23) connected to the current supply

conductors (8, 9).

4. A drive unit according to claim 1, 2, or 3, c h a r a c t e r i z e d in that the stored operating parameters comprise a predetermined maximum supply current for the drive motor (1) of the unit, that means for monitoring voltage and current to the motor are connected to the microprocessor (6), and that the microprocessor (6) is programmed to calculate the current maximum current on the basis of the measured motor current and, when exceeding the stored maximum supply current, to initiate an adjustment of the motor voltage for reduction of the supply current to the stored maximum value.

5. A drive unit according to claim 4, c h a r a c t e r i z e d in that the current and voltage to the motor (1) are controlled by pulse width modulation, and that the current supply current is calculated by multiplication of the measured motor current by the duty cycle of the pulse width modulated signal.

6. A drive unit according to claim 5, c h a r a c t e r i z e d in that the adjustment of the motor voltage is effected by control of the pulse width modulated signal.

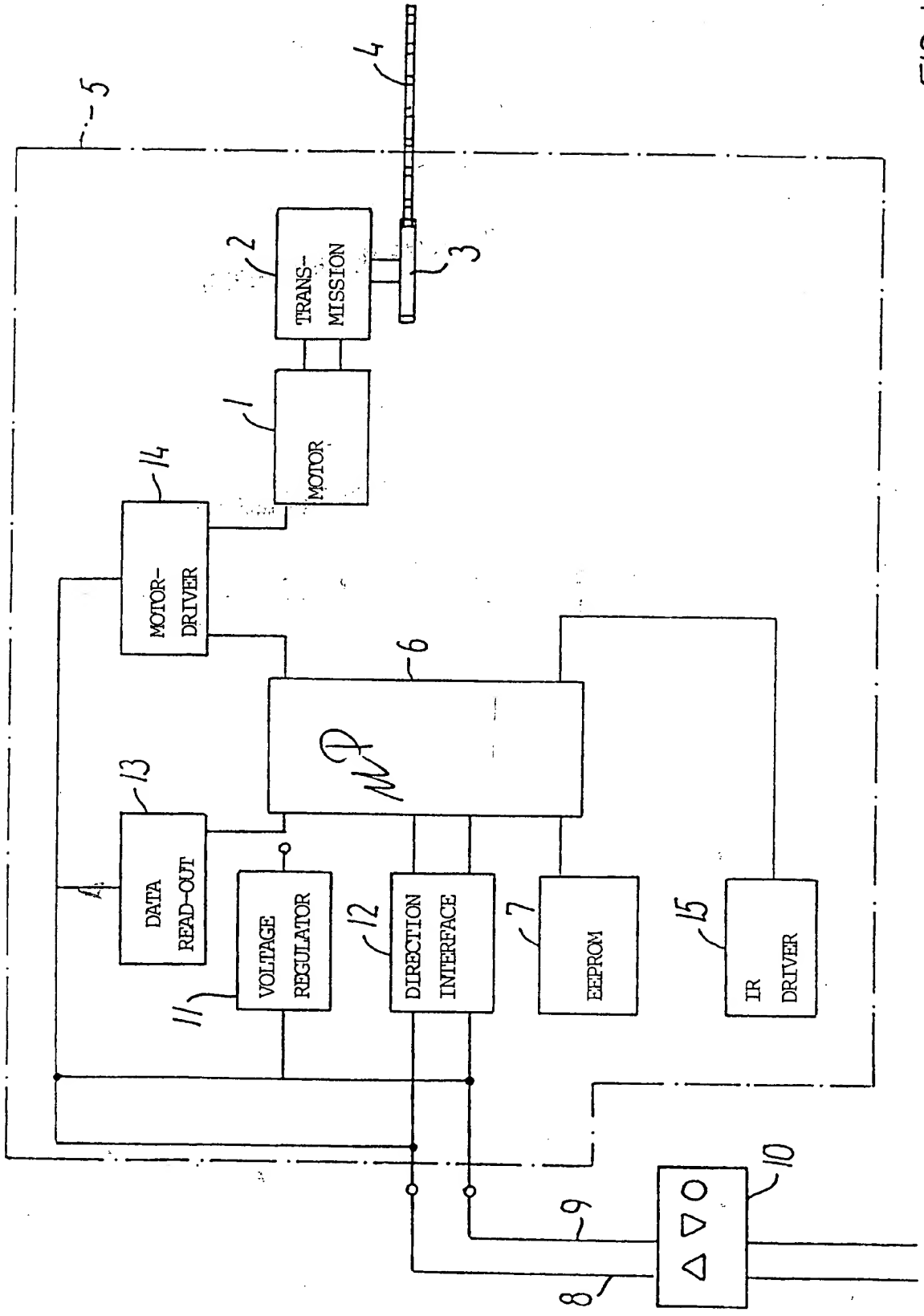

5
4
2
TRANS-
MISSION
3
1
MOTOR
14
MOTOR-
DRIVER
6
μP
13
DATA
READ-OUT
11
VOLTAGE
REGULATOR
12
DIRECTION
INTERFACE
7
EEPROM
15
IR
DRIVER
10
9
8

FIG. 1

BLANK (USP

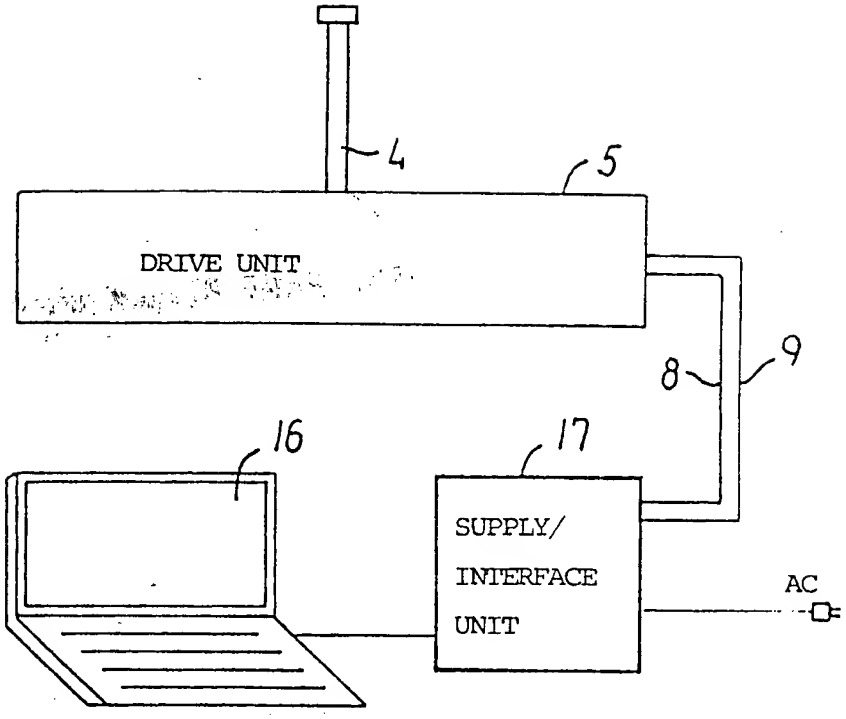

4
5
DRIVE UNIT
8
9
16
17
SUPPLY/
INTERFACE
UNIT
AC

FIG.2

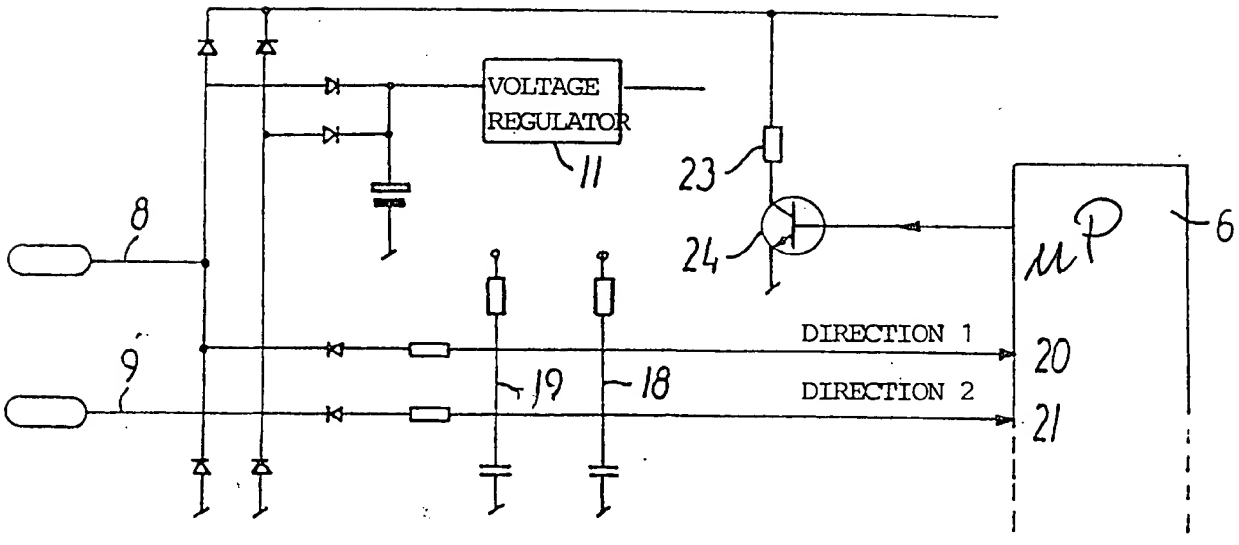

VOLTAGE
REGULATOR
11
23
24
8
9
19
18
DIRECTION 1
DIRECTION 2
20
21
μP
6

FIG.3

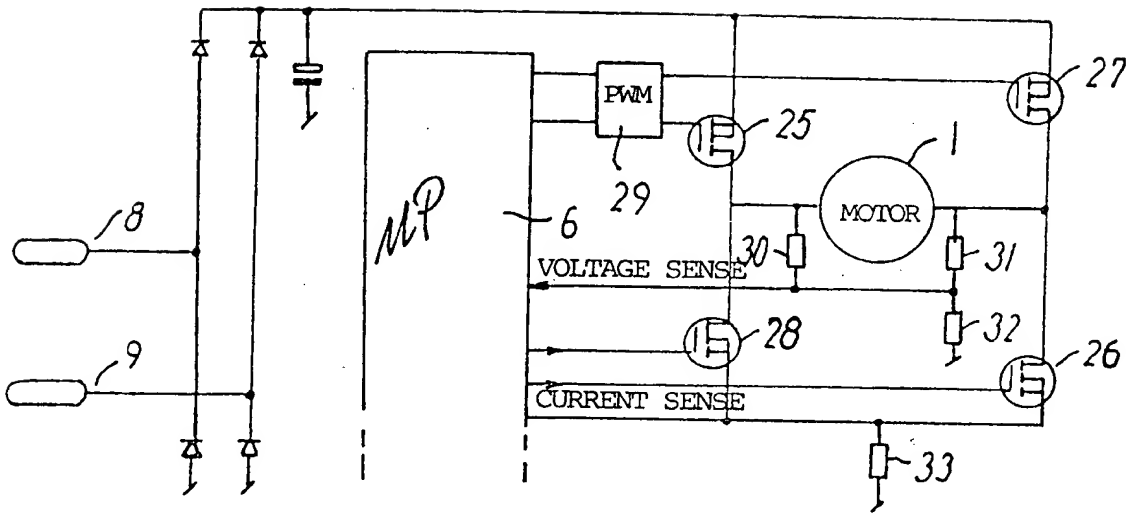

PWM
29
25
27
1
MOTOR
MP
6
8
9
VOLTAGE SENSE
30
31
28
32
26
CURRENT SENSE
33

FIG.4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/DK 98/00065

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: G06F 13/38, H04B 3/54, E05F 15/10, H02P 7/29
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: G11C, H04B, G05F, H02P, G06F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	GB 2202967 A (MICHAEL JOHN WILKINS), 5 October 1988 (05.10.88), page 6, line 23 - page 7, line 2; page 7, line 15 - line 20, abstract --	1-6
Y	EP 0650267 A2 (BERNEY), 26 April 1995 (26.04.95), column 1, line 5 - line 22 --	1-6
Y	GB 2189906 A (RICHARD EVAN JONES), 4 November 1987 (04.11.87), page 1, line 44 - line 62, abstract --	3

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
17 July 1998	27 -07- 1998
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. + 46 8 666 02 86	Authorized officer Anna Theander Telephone No. + 46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.
PCT/DK 98/00065

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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INTERNATIONAL SEARCH REPORT

Information on patent family members

30/06/98

International application No.
PCT/DK 98/00065

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		DE 59300408 D	00/00/00
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		SE 0592927 T3	
EP 0735665 A2	02/10/96	JP 8275584 A	18/10/96